

WHAT IS CLAIMED IS:

1. An optical device including a lens element and an optical element, the optical device comprising:
a supporting substrate ⁽¹⁰⁾ supporting said optical element, the supporting substrate ⁽¹²⁾ having a grooved surface ⁽¹³⁾ with a first groove; and
an optical substrate ⁽¹¹⁾ having a first surface on which the lens element is formed, a second surface, and a first projecting part disposed on the second surface, the first projecting part resting in the first groove in the grooved surface of the supporting substrate, the lens element thus being aligned with said optical element.

2. A method of fabricating the optical device of claim 1, comprising the steps of:
using photolithography to define the first projecting part; and
using photolithography to define the first groove.

3. The optical device of claim 1, wherein the grooved surface of the supporting substrate has a second groove, and the optical substrate has a second projecting part, disposed on said second surface, resting in the second groove, thereby assuring correct alignment of the lens element and the optical element.

4. The optical device of claim 3, wherein the grooved surface of the supporting substrate has a third groove disposed parallel to the first groove and the second groove, said optical element being an optical fiber disposed in the third groove.

5. The optical device of claim 1, wherein the supporting

substrate has an edge adjacent to the second surface of the optical substrate, and the first groove extends to said edge.

6. The optical device of claim 5, wherein the grooved surface of the supporting substrate has a second groove disposed parallel to the first groove, the second groove extending to said edge, said optical element being an optical fiber disposed in the second groove.

7. The optical device of claim 5, wherein the grooved surface of the supporting substrate has a second groove and a third groove both disposed parallel to the first groove, the second groove and the third groove both extending to said edge, the optical substrate has a second projecting part disposed on said second surface, resting in the second groove, and said optical element is an optical fiber disposed in the third groove.

8. The optical device of claim 1, wherein the supporting substrate is crystalline, and the first groove has a V-shaped cross-section.

9. A method of forming the optical device of claim 8, comprising the step of:

forming the grooved surface of the supporting substrate by etching the supporting substrate with an anisotropic etchant.

10. The optical device of claim 1, wherein the supporting substrate comprises:

a polymer substrate; and

a grooved resin layer disposed on the polymer substrate, forming the grooved surface of the supporting substrate.

11. A method of forming the optical device of claim 10, comprising the steps of:

coating the polymer substrate with a photosensitive resin layer;

selectively exposing the photosensitive resin layer to light through an exposure mask, thereby curing the exposed parts of the photosensitive resin layer; and

removing those parts of the photosensitive resin layer that are left uncured, thereby forming the grooved resin layer.

12. The optical device of claim 1, wherein the first projecting part extends perpendicularly from the second surface of the optical substrate and has a circular cross-section.

13. The optical device of claim 1, wherein the optical substrate comprises a quartz substrate, and the first projecting part comprises a resin material attached to the quartz substrate.

14. A method of fabricating optical device of claim 13, comprising the steps of:

coating the quartz substrate with a photosensitive resin layer;

selectively exposing the photosensitive resin layer to light through an exposure mask, thereby curing part of the photosensitive resin layer to form the first projecting part; and

removing those parts of the photosensitive resin layer that are left uncured.

15. The optical device of claim 1, wherein the projecting part and the optical substrate both comprise silicon, and

the first projecting part is unitary with the optical substrate.

16. The optical device of claim 1, wherein the lens element comprises a computer-generated hologram.

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